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MANAGING ENGINEERING AND CONSTRUCTION INFORMATION: AN INDUSTRY OVERVIEW

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William B. Moore
Robert A. Hutchinson

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LOGISTICS MANAGEMENT INSTITUTE
6400 Goldsboro Road
Bethesda, Maryland 20817-5886

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The Corps of Engineers Automation Plan (CEAP) and the Information Systems Modernization Program (ISMP) are multiyear efforts that are intended to meet the Corps information needs today and into the 21st century. CEAP is primarily a hardware and communications plan, while ISMP addresses the major business processes and attempts to ensure that both efforts support existing policy and take advantage of existing and expected technology improvements.

As part of an effort to answer these questions, the ISMP Executive Steering Committee tasked the Logistics Management Institute to examine current engineering and construction industry information management practices and provide an overview of these practices and the software available for project management. This report provides the findings, conclusions, and recommendations of the study.

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Special appreciation is extended to those companies that generously offered their time and expertise during the industry forum and industry interviews: Timberline Software, Primavera Systems, AGS Management Systems, Metier Management Systems, The Port Authority of New York and New Jersey, Edwards and Kelcey, Fluor Daniel, DuPont, Lummus Crest, and Morrison Knudsen.

This study and report were completed by the Logistics Management Institute (LMI) under contract to the Department of Defense. Key persons from LMI were Mr. William B. Moore, Mr. Robert A. Hutchinson, and Dr. Robert Crosslin.

Executive Summary

MANAGING ENGINEERING AND CONSTRUCTION INFORMATION: AN INDUSTRY OVERVIEW

The Corps of Engineers Automation Plan (CEAP) and the Information Systems Modernization Program (ISMP) are multiyear efforts that are intended to meet the Corps information needs today and into the 21st century. CEAP is primarily a hardware and communications plan, while ISMP addresses the major business processes and attempts to ensure that both efforts support existing policy and take advantage of existing and expected technology improvements.

The large cost predicted for CEAP/ISMP has caused the U.S. Army Corps of Engineers (USACE) senior managers to question whether these programs are overly ambitious and are likely to experience significant cost overruns and failures, and whether existing software applications are available that with reasonable modification could meet USACE needs. As part of an effort to answer these questions, the ISMP Executive Steering Committee tasked the Logistics Management Institute to examine current engineering and construction industry information management practices and provide an overview of these practices and the software available for project management.

We found that large private sector engineering and construction organizations are struggling with the same issues that are being faced by the Corps of Engineers. Although the specifics of each organization's plan are unique, there are a number of common themes. These organizations limit themselves to a planning horizon of 5 years or less, seldom employ single corporate databases, rely on modified off-the-shelf software for project management needs, develop financial software internally, make system investment decisions based upon affordability and the desire to stay competitive, do not feel compelled to adopt new technologies unless they make good business sense, and ensure corporate support by having senior managers involved in information efforts. We believe that these themes, as exhibited in well-managed engineering and construction organizations, provide valuable insights that can

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maximize the probability of USACE's information systems modernization program being successful.

To maximize the benefits realized from the lessons learned, we recommend the following concepts be incorporated into the Corps of Engineers Information Systems Master Plan:

- Develop separate finance and accounting and project management databases.
- Continue development on a new finance and accounting system.
- Procure an off-the-shelf project management system that will become the primary base for Corps project management.
- Continue development on a Corps-wide data dictionary which identifies data elements that can serve as keys to link these databases.
- Concentrate planning efforts on the next 5 years. A draft of a 5-year plan that emphasizes implementation issues should be presented to the ISMP Steering Committee within 6 months.
- Ensure the responsiveness of information system projects to organization needs by establishing firm milestone schedules that require the delivery of products 6 to 18 months after project initiation.
- Maintain corporate support of information system modernization efforts by continuing the ISMP Executive Steering Committee.

We believe that the recommendations contained in this report along with those of the Private Sector Council and internal USACE evaluations provide the basis for a reevaluation and redirection of the Information System Modernization Program.

CONTENTS

CHAPTER 1

INTRODUCTION

BACKGROUND

The Corps of Engineers Automation Plan (CEAP) and the Information Systems Modernization Program (ISMP) are multiyear programs to "provide a cost-effective solution for meeting Corps of Engineers' life cycle project management, program management, and functional information requirements both now and into the 21st century." CEAP is a hardware and communications plan to replace existing obsolete or incompatible equipment with integrated systems and extensive communications capabilities. Conversely, ISMP addresses the major business processes and attempts to ensure that both efforts support current policy and take advantage of existing and expected technology improvements. Information managers within the U.S. Army Corps of Engineers (USACE) believe the combination of these two programs will meet the Corps information needs well into the future.

Given the magnitude of the resource requirements to meet the current target configuration for CEAP/ISMP, USACE senior managers have raised a number of questions concerning CEAP/ISMP. Two key questions are:

(1) Do software applications exist that, with a reasonable amount of modification, could meet USACE needs?

(2) Is CEAP/ISMP overly ambitious and are significant cost overruns and failure to meet stated objectives likely outcomes?

Three organizations were tasked to examine various aspects of these two concerns:

- The Director of Resource Management obtained the services of the Private Sector Council (PSC) to evaluate the ISMP concept as it applies to financial management systems.
- The Waterways Experimentation Station was tasked to assess the technical capabilities of selected project management software packages.
- The Logistics Management Institute (LMI) was tasked by the ISMP Executive Steering Committee to examine current engineering and

construction industry information system trends, the software available for project management, and the practices of six large engineering and construction organizations.

ANALYSIS FRAMEWORK

We identified industry trends by interviewing engineering and construction trade associations and reviewing recent surveys of the industry. We interviewed four trade associations: Amercian Association of State Highway and Transportation Officials (AASHTO), American Consulting Engineers Council (ACEC), American Institute of Architects (AIA), and Construction Management Association of America (CMAA). Industry trade associations were also consulted to identify engineering and construction organizations that were reflective of good information management practices. Based on the first round of interviews, we selected six engineering and construction organizations for interviews: DuPont, Edwards and Kelcey, Fluor Daniel, Lummus Crest, Morrison Knudsen, and The Port Authority of New York and New Jersey. Teams made up of members of the ISMP Executive Steering Committee and LMI representatives then interviewed top executives and information management experts from these organizations. The results of these interviews were used to develop the overview of industry practices. (See Appendix A for a list of individuals interviewed.)

A similar approach was used to identify existing software capabilities. Industry trade associations were again queried to identify vendors that produced software which was used extensively by engineering and construction companies. These vendors – AGS Management Systems, Metier Management Systems, Primavera, and Timberline were then invited to make presentations to a panel consisting of members of the ISMP Executive Steering Committee and the LMI staff. This panel questioned the vendors in detail and the results of that questioning is contained in Appendix B. The analysis of software was similar to that used for industry practices except that the willingness of vendors to respond to customer desired changes was added.

The remainder of this report presents the findings, conclusions, and recommendations of the study. In Chapter 2, the findings of the industry and the software vendor interviews are shown along with some industry-wide statistics. In Chapter 3,

conclusions and recommendations are made. Collected data and lists of organizations and individuals contacted are contained in the Appendices.

CHAPTER 2

FINDINGS

The findings of this study are presented in three sections: industry trends, software capabilities, and the practices of six large engineering and construction organizations. We define industry trends as the information system practices of architect-engineer (AE) and construction management firms. Software capabilities are the features of software applications that are commonly used in the engineering and construction industries. The practices of large engineering and construction organizations are the information system policies for the six selected organizations which were chosen to illuminate specific actions and policies that are relevant to Corps of Engineers information systems management.

INDUSTRY TRENDS

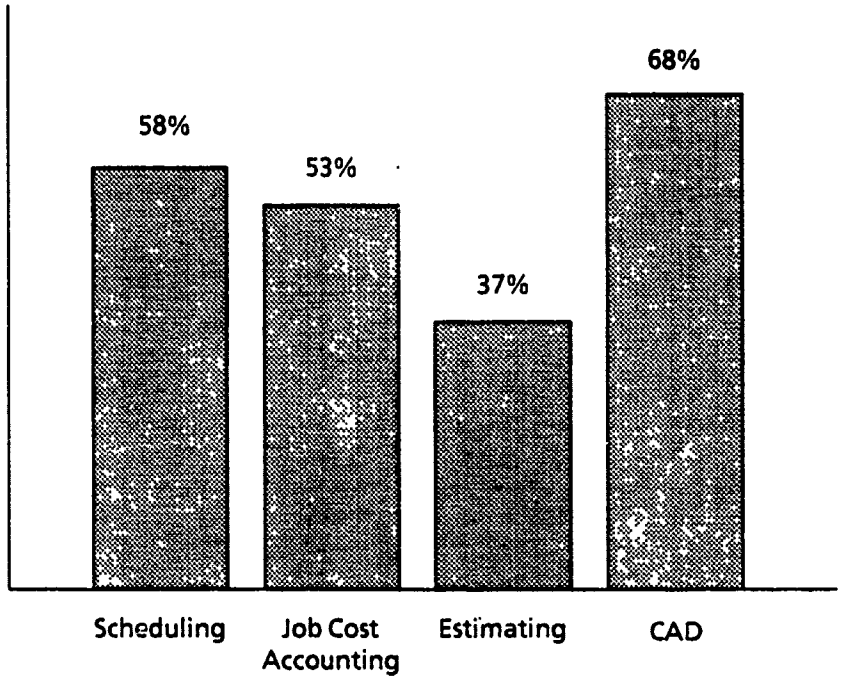
Architect-Engineer Trends

The use of information systems resources by AE firms is dominated by four applications: computer-aided design (CAD), scheduling, job cost accounting, and estimating (see Figure 2-1). CAD, not surprisingly, is the most frequently used application. Although CAD has not always enhanced profit performance,[1] many AE firms believe they must develop a CAD capability for marketing reasons and the fear of being technically less capable than competitors.

Scheduling is the next most frequently used application and reflects a general industry trend to more comprehensive project management. Job cost accounting and estimating make up the remainder of the most frequently used applications. It is interesting to note that job costing and estimating, which used to be the most frequently used information systems application, have been surpassed by CAD and scheduling applications.

MS DOS™ is the operating system most frequently used by surveyed AE firms. This reflects the heavy use of microcomputers by those firms (see Figure 2-2). This is

[1]Practice Management Associates, *PSMJ Financial Statistics Survey* (Boston: Practice Management Associates, 1987), p.29.



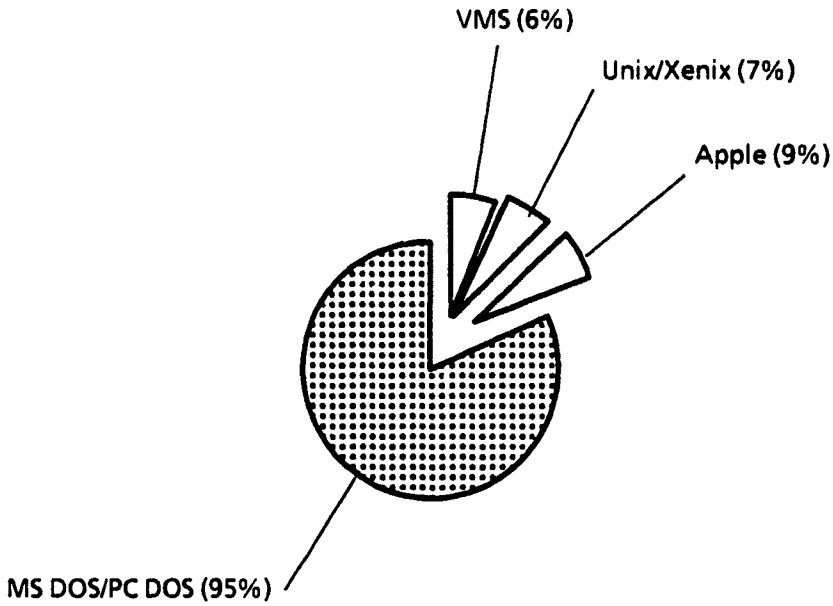
Source: A-E-C Computer Market Study, 1988, conducted by McGraw-Hill – ENR

FIG. 2-1. COMPUTER USAGE BY AE FIRMS

due in part to the composition of the AE industry which has a large number of smaller firms, and may not be reflective of the practices of large AE organizations.

Of the AE firms surveyed, 74 percent do not currently employ local or wide area networks, and only 39 percent of these plan to implement such networks in the near future. Although this result is influenced by the large number of small AE firms in the industry, it nevertheless indicates that AE firms place little emphasis on establishing local or wide area networks.

Industry trade organizations such as the American Consulting Engineers Council (ACEC), the American Institute of Architects (AIA), and the American Association of State Highway and Transportation Officials (AASHTO) believe that there is an increasing trend toward application integration. This belief was confirmed during discussions with software vendors, most of whom claimed that the integration of applications such as project management with cost accounting, etc., is their most active market segment. Increases in integration will likely increase the



Source: A-E-C Computer Market Study, 1988 conducted by McGraw-Hill – ENR.

FIG. 2-2. OPERATING SYSTEMS USED BY AE FIRMS

use of networking since many of the applications being integrated frequently reside on different platforms.

AE firms devote significant financial resources to information system management efforts. Table 2-1 shows the typical expenditures made by AE firms. These costs are allocated within the organization in a number of ways. Table 2-2 displays the results of a survey of AE firms on how they allocate information systems management costs.

Construction Management Trends

The use of information systems resources by construction management (CM) firms is dominated by applications for job costing, accounting, project management, CAD, general administrative functions, and estimating (see Table 2-3). CM firms, like their AE counterparts, have become greater practitioners of project management in the past few years. Significant amounts of information systems resources are being devoted to scheduling, project planning, and other project management tasks. Job costing, estimating, and other financial management applications continue to be major consumers of information systems resources. Although the

TABLE 2-1

COST PER TOTAL STAFF FOR HARDWARE AND SOFTWARE BY AE FIRMS

	Lower quartile	Mean	Median	Upper quartile
Word processing	$ 293	$ 607	$ 500	$ 790
Accounting/financial	311	671	550	861
Technical	274	730	455	892
Computer-aided design & drafting (CADD)	675	1,642	1,253	2,326
Total computer cost per employee	$ 1,384	$ 2,795	$ 2,333	$ 3,750

Source: PSMJ Financial Statistics Survey, 1987.

TABLE 2-2

METHODS USED BY AE FIRMS TO ALLOCATE COMPUTER COSTS

Method used	% of respondents
Costs treated as direct (project) costs	25
Costs treated as overhead (indirect) costs	43
Costs treated as both direct and overhead costs	32
Costs allocated by standard units available	25
Costs allocated by actual units used	50

Source: PSMJ Design Services Fee Structure Survey, January 1989.

CMAA survey captured information systems costs by the volume of managed work, a comparison with AE per-employee expenditures can be made by dividing the survey costs by the average number of employees for CM firms doing that volume of work. When this is done, it appears that both large and small CM firms are spending significantly less on information systems than their AE counterparts. Tables 2-4 through 2-7 show levels of hardware and software expenditures for construction management firms responding to the CMAA survey.

TABLE 2-3

CONSTRUCTION MANAGEMENT COMPUTER USAGE

Activity	Respondents	Percent
Job costing	46	60%
Accounting		
General ledger	35	46
Payables/receivables	35	46
Financial statements	37	48
Billing	26	34
Payroll/labor distribution	31	40
Project management		
Program management	17	22
Project planning	26	34
Project scheduling	45	58
Document control	17	22
Inventory control	7	9
Equipment management	8	10
Purchasing/expediting	12	16
CAD		
Engineering/CADD	17	22
Administrative		
Electronic mail	17	22
Word processing	53	69
Sales/marketing	11	14
Database applications	26	34
Spreadsheets	54	70
Other	10	13
Estimating	28	36%

Source: CMAA 1987 Survey of Construction Management Computer Usage Marsha D. Lewin and F J Schroeder, September 1987

TABLE 2-4

ESTIMATED EXPENDITURES ON HARDWARE ACQUISITION DURING NEXT YEAR BY CONSTRUCTION MANAGEMENT FIRMS

Annual value of managed work	None	<$10K	$10 – 50K	$50 – 100K	$100 – 500K	>$500K	Undis-closed
> $500 Million			3	1	1		
$200 – 500 Million	1	1	3				
$100 – 200 Million		1	2	1	1		
$50 – 100 Million	3	4	8	1			1
$10 – 50 Million	4	15	4	1			
< $10 Million	7	6	3	2			1
Undisclosed		1	1				
Totals	15	28	24	6	2	0	2
Percent	19.5%	36 4%	31 2%	7 8%	2.6%		2.6%

Source: CMAA 1987 Survey of Construction Management Computer Usage. Marsha D. Lewin and F. J. Schroeder, September 1987.

TABLE 2-5

ESTIMATED EXPENDITURES ON SOFTWARE ACQUISITION DURING NEXT YEAR BY CONSTRUCTION MANAGEMENT FIRMS

Annual value of managed work	None	<$5K	$5 – 10K	$10 – 50K	$50 – 100K	>$100K	Undis-closed
> $500 Million			1	3	1		
$200 – 500 Million	1	2	1	1			
$100 – 200 Million		2		3			
$50 – 100 Million	4	9		3			1
$10 – 50 Million	4	13	5	2			
< $10 Million	5	9	2	2			1
Undisclosed		1	1				
Totals	14	36	10	14	1	0	2
Percent	18 2%	46.8%	13 0%	18.2%	1 3%		2.6%

Source: CMAA 1987 Survey of Construction Management Computer Usage Marsha D Lewin and F J Schroeder, September 1987

TABLE 2-6

ESTIMATED EXPENDITURES ON SOFTWARE DEVELOPMENT DURING NEXT YEAR BY CONSTRUCTION MANAGEMENT FIRMS

Annual value of managed work	None	<$5K	$5 – 10K	$10 – 50K	$50 – 100K	>$100K	Undis-closed
> $500 Million	1	2		1	1		
$200 – 500 Million	1		3	1			
$100 – 200 Million		2	1	2			
$50 – 100 Million	5	5	3	3			1
$10 – 50 Million	9	10	4	1			
< $10 Million	6	11	1				1
Undisclosed	1	1					
Totals	23	31	12	8	1	0	2
Percent	29.9%	40.3%	15.6%	10.4%	1.3%		2.6%

Source: CMAA 1987 Survey of Construction Management Computer Usage Marsha D. Lewin and F. J. Schroeder, September 1987.

TABLE 2-7

ESTIMATED EXPENDITURES ON COMPUTER USAGE TRAINING DURING NEXT YEAR BY CONSTRUCTION MANAGEMENT FIRMS

Annual value of managed work	None	<$5K	$5 – 10K	$10 – 50K	$50 – 100K	>$100K	Undis-closed
> $500 Million		2	1	1	1		
$200 – 500 Million	1	1	1	2			
$100 – 200 Million		2		2	1		
$50 – 100 Million	2	10	2	2			1
$10 – 50 Million	12	5	7				
< $10 Million	4	12		2			1
Undisclosed		2					
Totals	19	34	11	9	2	0	2
Percent	24.7%	44.2%	14 3%	11 7%	2 6%		2 6%

Source: CMAA 1987 Survey of Construction Management Computer Usage. Marsha D Lewin and F J Schroeder, September 1987

SOFTWARE CAPABILITIES

Software capabilities were identified by interviewing industry trade associations, by analyzing software industry reviews for AE and CM applications,[2,3] and through a 2-day forum that was held for recognized leaders in the AE and CM software industries. Although the software developers attending the forum concentrated primarily on project management, other information systems subject areas were addressed as well. Capabilities were grouped into six functional categories: project management, finance and accounting, management reporting, integration, networking, and applicable hardware. A final area that was addressed was the willingness of vendors to respond to a request for proposals (RFP) requiring significant customization (see Appendix B for vendor replies to specific questions).

Project Management

The practice of project management has undergone many changes in recent years and has evolved into one of the leading management techniques. All of the vendors interviewed had impressive project management capabilities. In many cases, the basic capabilities, such as the number of tasks or projects that could be handled simultaneously meet or exceed Corps needs. Meeting some of the more specific requirements such as project management reporting would require varying degrees of customization depending upon what the final Corps requirements were determined to be. Table 2-8 shows the capabilities of some of the leading project management software packages.

Financing and Accounting

Most commercially available finance and accounting software applications are stand-alone systems designed for small engineering or construction firms or for large projects. None were identified that have been designed for an organization the size of the Corps. An accounting package for a large engineering or construction organization would be expensive to develop, yet would appeal to a relatively small market. Consequently, software vendors have shown little interest in creating such packages.

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[2]National Software Testing Laboratories, *Software Digest Vol. 5, Number 9: Project Management Software* (Philadelphia: National Software Testing Laboratories, 1988), pp. 3-59.

[3]"Product Comparison," *INFOWORLD*, 20 February 1989, pp. 53-63.

TABLE 2-8

HIGH-END PROJECT MANAGEMENT SOFTWARE CAPABILITIES

☒ Feature ☐ No Feature	Artemis Project Ver. 2.1.S	Open Plan Ver. 3.1	Portmaster Advance Ver. 2.1	Primavera Project Planner Ver. 3.1	Project Work-bench Ver. 3.0	Qwiknet Profes-sional Ver. 3.1	View-point Ver. 3.1
Tasks and Resources							
Tasks/project	64,000	10,000	2,000	10,000	Unlimited	5,000	32,000
Resources/project	255	U/500	Mem/Ltd.	Unlimited	200	Unlimited	32,000
Resources/task	255	U/250	Mem/Ltd.	Unlimited	200	100	32,000
Leveling over multiple projects	☒	☒	☒	☒	☒	☒	☒
Selective resource leveling	☒	☐	☐	☒	☐	☒	☒
Planning Capabilities							
Activity-on-node network	☒	☒	☒	☒	☒	☒	☒
Activity-on-arrow network	☒	☒	☒	☒	☐	☐	☐
Baseline schedule(s)	1	1	Unlimited	Unlimited	1	2	1
WBS codes	☒	☒	☒	☒	☒	☒	☒
Resource codes	☒	☒	☒	☒	☒	☒	☒
Subprojects	☐	☐	☒	☐	☒	☐	☒
Multiple calendars	☒	☒	☒	☒	☒	☒	☒
Minimum work unit	Hour	Minute	Minute	Day	Hour	Hour	Day
Calculates total float	☒	☒	☒	☒	☒	☒	☒
Calculates free float	☐	☒	☒	☒		☒	☒
Compatible File Formats							
Time Line 3.0	☒	☒	☐	☐	☒	☐	☐
ASCII	☒	☒	☒	☒	☒	☒	☒
Dbase		☒	☒	☒	☒	☒	☒
Microsoft Project	☐	☐	☐	☒	☐	☒	
LOTUS 1-2-3	☒	☒	☒	☒		☒	☒
Editing Capabilities							
Interactive Gantt	☐	☐	☒	☒	☒	☒	☒
Interactive PERT	250 Act.	☒	☒		☒	☒	☒
Search/sort filtering	☒	☒	☒	☒	☒	☒	☒
Split screen or windowing	☐	☒	☒		☒	☒	☐
Reporting							
Gantt chart	☒	☒	☒	☒	☒	☒	☒
PERT network	☒	☒	☒	Optional	☒	☒	Optional
Time-scaled logic diagram	☐	☒	☒	☒	☒	☒	☒
Histograms	☒	☒	☒	☒	☒	☒	☒
Earned value analysis	☒	☒	☐	☒	☐	☒	☒
Other							
Mass update	☒	☒	☐	☐	☐	☐	☒
Macros	☒	☒	☐	☐	☐	☐	☐
Plotter support	☒	☒	☒	Optional	☒	☒	Optional
Multiproject summary	☒	☒	☒	☒	☒	☒	☒

Source: Infoworld, February 20, 1989.

Management Reporting

Project management and finance and accounting software currently available on the market have a wide variety of reporting capabilities. Some can provide only basic standard reports while others have internal relational database structures which are combined with report writer capabilities. None of the packages examined was able to consolidate report information for various organizations or projects automatically, although many could be modified to create this capability.

Integration

Providing integration between different types of applications such as project management and accounting is a major objective of many software vendors. Currently, few software packages possess any significant integration capabilities. Most efforts at integration rely upon the transfer of flat files in either ASCII or in the format of frequently used applications such as LOTUS 1- 2-3™ or dBASEIII+™. Most integration between packages is accomplished by importing a flat file into a database that is internal to the application. This internal database provides inputs to the follow-on application. The internal database may be a relational structure or it may simply be a two-dimensional matrix in a flat file format.

Networking

Most of the software packages examined could be run in a network configuration. This capability was frequently created by making the project management software compatible with that of one of the leading vendors for local area networks (LANs). Those packages that did not have this capability relied upon modem communication to move information between various hardware platforms.

Hardware Trends

The ability of the packages to operate on different hardware platforms (mainframe, mini, micro) varies greatly. A large number of packages can only run on microcomputers. Some have versions that can run on both microcomputers and minicomputers and may or may not be able to easily communicate with each other. A few have the ability to operate on all three types of platforms and some of these can transfer information readily between platforms.

Most vendors wanted to increase the number of platforms upon which their software could operate. However, it appeared that most interest was in making mainframe versions compatible with minicomputers and microcomputers. Some vendors with microcomputer versions were making them compatible with popular minicomputers, but few were interested in moving up to mainframe versions. This was due in part to the belief by software vendors that it would take some period of time before they could develop project management applications that would fully exploit the capabilities available in the newest microcomputers.

Vendor Interest in RFPs

Software vendors were queried on their interest in responding to RFPs that would require them to modify their existing packages to incorporate additional capabilities. It was not surprising that all vendors stated they were interested. In our opinion, some packages could likely be modified at a reasonable cost and with a high probability of success. This is particularly true for those products that are in essence themselves a 4th generation language and where the modifications are primarily changes to report formats. However, other packages could not be readily modified and the probability of successfully incorporating major enhancements is low. An RFP requiring the modification of an existing product would likely have a reasonable number of offerors who would have to be evaluated carefully to determine if they could perform as promised.

THE PRACTICES OF LARGE ENGINEERING AND CONSTRUCTION ORGANIZATIONS

Six organizations were interviewed to determine the information systems practices of large engineering and construction concerns. The group included a quasi-governmental corporation responsible for a multibillion dollar program, engineering and construction firms with annual sales measured in the billions of dollars, a large owner that did its own construction management and some design, and a progressive engineering firm with state-of-the-art management information systems. Our findings are reported in ten subject areas: planning horizon, corporate databases, project management, finance and accounting, reporting, integration, networking, hardware trends, information systems costs, and corporate support of information systems programs.

Planning Horizon

The planning horizon for information systems managers is generally limited to a 3- to 5-year period. This limitation was the result of two factors. First, information systems managers believe that technology is moving so rapidly that planning beyond that period is futile. Any plan further in the future would likely be overcome by technology advances and made obsolete far before it was implemented. Second, most organizations demanded results from information systems within 6 to 18 months of inception. Unstated, but implied, was the fact that most information systems managers are overwhelmed with detailed implementation plans for the next 5 years and have little time for visionary thinking. Although information systems managers state that they do not plan beyond a 5-year period, many indicate that they do have conceptual plans for the period beyond a 5-year horizon. These long-range plans have not been formalized in most cases and usually have the objective of ensuring that current decisions do not block the implementation of future technologies such as relational and distributed databases when and if it is decided to employ them.

Corporate Databases

No organization interviewed employed a single corporate database to maintain all or even most corporate information. All organizations interviewed are familiar with relational database technology; however, none have or are developing a single relational database that would meet all management information needs. Most employ a combination of relational structures and more dated technologies such as hierarchical or network databases.

The reasons for this employment of technology vary. Many are constrained by the cost of replacing existing systems, and some voice concerns that distributive and relational database technologies are not well enough developed for them to feel comfortable with using them as the backbone of their information systems. Most realize that a single relational database has significant benefits once cost and technology concerns are overcome, and many information managers are being careful to preserve their ability to move toward a single large relational structure at some future time. However, none saw an immediate need to move to such an information strategy.

Project Management

All organizations interviewed believe in the need for effective project management systems. The desire for effective project management is the catalyst for many information systems innovations. Managers of engineering and construction organizations are emphatic in their belief that a strong decentralized project management organization is essential to success in the engineering and construction industry.

Although nearly all project management systems employ extracted information from a cost accounting or financial system, all firms but one have separate project management and financial databases. There is a recognition that project management cost numbers and those in the "official" financial records are frequently out of sync because of the timing of update cycles, labor distributions, etc. This is acknowledged to cause some problems, but is viewed as an acceptable cost for having timely information available for project managers. Most information managers did not feel an immediate need to implement system changes which would ensure that information from either source would be identical.

A number of different software packages are used for project management. Most organizations have a corporate standard, but permit project managers to use other systems as long as standard reports are submitted. Most standard reports are submitted in hard copy form eliminating the need for upward software compatibility. Most organizations employ off-the-shelf project management software. In most cases, this software is modified to meet the specific needs of an organization, but even in those instances, information systems managers believe it is more cost-effective to start with an existing package than to develop an application from scratch. Various platforms are used to support project management software. Project managers always have access to the project management database no matter which platform (microcomputer, minicomputer, or mainframe) is selected; however, they are generally not permitted to change cost data that has been extracted from the financial system.

Finance and Accounting

Finance and accounting remains the single largest function, in terms of transactions processed and stored, that engineering and construction information systems must support. This function is supported through a number of different

strategies. When projects are large enough, they frequently have on-site systems that perform finance and accounting with summary reports being forwarded to corporate offices. In other cases, a centralized finance and accounting system is employed. The centralized system may meet all finance and accounting needs, specialized needs such as payroll, or a combination of needs.

Information systems managers believe that no financial software exists that meets the needs of large engineering and construction organizations in either the private or the public sectors. Existing finance and accounting systems did not use relational database technology, however, newer and planned applications are generally using this technology. Some organizations state that they plan to use an off-the-shelf relational database application, such as ORACLE™, that would eventually run on a number of different platforms as the basis for new development efforts.

It was clear that changes to the finance and accounting system are considered to be major events of epic proportion which are only undertaken after serious deliberation. In part, this is due to the legal aspects of financial data for Internal Revenue Service and annual reporting which must be correct and on time. Consequently, many of the finance and accounting systems continue to be based on outdated technology. It is likely that these technologies will continue to be used for some time, given the aversion to change and the belief by many managers that their information needs are being met with existing systems.

Management Reporting

Upward reporting capabilities are not major information systems issues for the organizations interviewed. With one exception, little of the detailed cost or project management information is reported to corporate headquarters. Most organizations identified 10 to 20 key elements of information that are considered critical success factors. These factors are then summarized in corporate level reports. In one major corporation, only three lines of information per project are reported to top managers. The inputs for these reports come from either corporate and/or project level financial databases and project management databases. In most cases, they are transmitted by hard copy summary provided from subordinate offices within the organization. There is also a belief that data contained in these reports are not very perishable since it is summary data intended to enable corporate managers to identify trends,

and not to support real-time decision making. Consequently, information managers believe that data which is up to a month old is acceptable. Likewise, there is little desire to provide corporate managers with real-time query capabilities down to the project level. The general belief is that the details are the responsibility of the project manager, and that corporate managers should be concerned with more summary information.

Integration

Most engineering and construction organizations did not view the integration of applications as essential for successful information systems management. Project management and finance and accounting are the most frequently integrated applications. Many existing project management and general business applications provide that capability in a limited sense through the transfer of ASCII files or industry standard formats. Applications developed in-house rely almost exclusively on ASCII flat file transfers. Few managers believe that the benefits of greater integration are worth expending large amounts of resources to achieve. Software vendors are providing most of the impetus for integration and the organizations interviewed seem content with letting these vendors develop the technology that permits applications to communicate with each other as the market dictates.

Networking

All organizations interviewed use networking to some degree. Both local area networks (LANs) and wide area networks (WANs) are used. LANs are most frequently used within a division or project office where a number of microcomputers are networked together using vendor-supplied software. Some LANs are employed where microcomputers and mainframes coexist. More often, however, when microcomputers are employed with mainframes, they are used in a terminal emulation mode. Few organizations have true WANs. In most instances where communications are required across large distances, dedicated point-to-point lines are employed generally linking two mainframe computers. Some organizations do have conceptual plans for future linking of various sites and types of platforms, but actual implementation is not scheduled until some time in the future.

Hardware Trends

The increases in computing power that microcomputers have experienced have had major impacts on hardware trends for engineering and construction organizations. The number of and reliance upon mainframe computers have decreased during the past 5 years in every organization interviewed. All of the organizations interviewed, except two, are meeting their mainframe computing requirements with a single machine. Microcomputers are being used for many different applications throughout the industry. The new microprocessors available permit even complex applications to be run on relatively inexpensive microcomputers. At the same time, there is recognition that some information systems needs will continue to be met with mainframe or minicomputer applications due to the volume of transactions, the amount of storage required, control of data concerns, etc. The maintenance of financial records is frequently mentioned as such a need. Most organizations interviewed see a continuing trend toward more microcomputers in their hardware mix, but with mainframe and minicomputers playing a major role in meeting information needs for a number of years.

Information Systems Costs

There are two major concerns when examining information systems resource requirements: how much it costs and who pays for it? A number of different cost allocation approaches are used. Some organizations treat information systems costs as a general overhead item and share it back to all organization elements the same as they would other corporate overhead items. Most profit-making engineering and construction organizations attempt to charge information systems costs directly to the beneficiary of the system. In some cases, this means charging costs to departments, while in others, it means charging directly to projects. Costs not directly charged are then treated as general overhead. Ostensibly, this approach results in a more efficient use of information systems resources. Users are willing to pay only for those services that produce a benefit equal to or greater than their cost. Thus, information services that provide little utility will be discontinued.

Another trend is the way the industry analyzes information system expendi tures. Historically, a return on investment (ROI) approach was used to justify major information systems development expenses. This approach has been used less and less in recent years. This trend has been caused by the complexity of new

information systems in which many different functions may be affected by a single new system. For example: when a typewriter is replaced with a microcomputer that has word processing among other capabilities, should it be compared against the cost of the typewriter only, or should the additional capabilities somehow be accounted for? Likewise, how are new information capabilities costed when no historical experience exists? Another contributing factor is the difficulty in calculating the value of intangible benefits such as quality and responsiveness improvements. Although some organizations use a cost-benefit approach to evaluate information systems alternatives, most state that information systems decisions are frequently made on what is needed to keep up with competition and what the company could afford and not on a strict ROI analysis. Table 2-9 shows expenditures for information systems for the organizations interviewed.

TABLE 2-9

INFORMATION SYSTEMS EXPENDITURES FOR THREE LARGE ENGINEERING AND CONSTRUCTION ORGANIZATIONS

Per staff employee	Percent of gross revenues
$2,361	3%
N/A	3%
$2,000	5%

Corporate Support

All organizations interviewed believe that the involvement and support of top management is critical to the success of information system projects. In all organizations interviewed, senior executives make major information systems decisions. They also ensure that senior executives input to information systems projects through steering committees, etc. The organizations interviewed believe it is this senior management involvement that ensures that information systems support corporate objectives.

CHAPTER 3

CONCLUSIONS AND RECOMMENDATIONS

The Corps of Engineers is not the only large construction and engineering organization undergoing major changes in its information systems. Every organization interviewed is facing the same questions that the Corps of Engineers is currently trying to answer. Determining how much to spend, how much technology is enough, what technologies are right for the organization, and how the organization plans future information systems are challenges that all large construction and engineering organizations are struggling with. Each organization interviewed is pursuing an information systems plan that recognizes its corporate culture, the need to keep up with competitors, the desires of senior managers, and what it can afford. Although the specifics of each organization's plan are unique, there are a number of common themes that exist and should be considered when developing an information systems plan.

CONCLUSIONS

Planning Horizon

The planning horizon for information systems has become truncated by the speed of technology advances. A planning horizon of 3 to 5 years is all that can be reasonably addressed. Beyond that, it is a guess as to what technologies will be available and at what cost. Strategic plans that extend well into the future have some value as mechanisms to ensure that the use of future technologies is not precluded by current decisions, to the extent that this is possible. However, the limitations of long-range plans should be recognized, and planning efforts should focus on a period of 1 to 5 years into the future with particular emphasis on near-term implementation plans.

The Use of Corporate Databases

Large databases that contain all pertinent corporate information are not currently used by the engineering and construction industry, nor is it likely that they will be commonly used in the near future. Relational database theory makes

such data structures a possibility, but effective implementation for a large corporate database would, in most cases, require distributive storage and/or processing. These technologies are available, but not considered well enough developed by the industry to be relied upon for the information needs of large engineering and construction organizations. The benefits of relational structures are well recognized and many organizations are ensuring that future systems developments will either be based upon relational theory or be capable of being integrated into a relational structure.

Off-the-Shelf Software

The use of off-the-shelf software is an important part of engineering and construction information systems. There is nothing to be gained by reinventing algorithms for calculating critical paths, etc. This is not to say that all information needs can be met with off-the-shelf software. Scheduling and project management needs are being met by either modifying off-the-shelf software or using it in its standard configuration. Although we did not undertake a detailed comparison of the ISMP requirements and the software packages described in Appendix B, it appears that USACE could successfully modify a number of these packages to meet general scheduling and project management needs. Finance and accounting software for large engineering and construction organizations, however, is virtually non-existent and is developed separately for each user. Although developed by the user, finance and accounting software is frequently based upon an off-the-shelf, relational database application such as ORACLE™ or INGRES™.

A distinct advantage of using off-the-shelf software, to the extent that it is practical, is that the user can keep up with software advances via updates. If a leading software vendor is selected, it is likely that it will keep up with technology improvements and ensure that its product utilizes these improvements to the fullest. In fact, it must do this if it is to survive in the highly competitive software market. If a finance and accounting system is based upon ORACLE™, for example, it is likely that the software will be updated periodically to incorporate the latest practical technology. Methods for converting existing code to the new standard are normally provided since such products have a large base of existing users that must be supported if a vendor is to market future products successfully. Although there are always costs associated with any conversion, riding the coattails of a leading vendor is usually the least expensive way of keeping up with technological advances.

The Integration of Software Packages

The firms we interviewed viewed the integration of software applications as an enhancement to information systems which is nice to have, but not worth spending a lot to achieve. Software applications that readily transfer data between each other are clearly advantageous. With few exceptions, engineering and construction organizations are content to let vendors pursue the means to make this happen for specific applications at their own expense. Home-grown systems are generally integrated with commercial applications by passing flat files in ASCII format. There is little immediate interest in developing relational structures that would provide for the sharing of data among applications even though this is the logical conclusion of an integration effort.

Communication Within and Between Information Systems

The communication capabilities that are available for use within and between information systems have increased greatly in the last 5 years. Many options are currently available for communications between micro, mini, and mainframe computers. Software is readily available for configuring both local and wide area networks. Current usage in the industry is generally limited to local microcomputer and mini/microcomputer networks. The predominant mainframe communications are through micro or minicomputers acting as dumb terminals or mainframe-to-mainframe via a dedicated line. Communication capabilities currently available are well beyond what the engineering and construction industry is ready to use, and are considered by industry managers to be cost-prohibitive.

Evaluating the Cost of Information Decisions

Managers like to evaluate decisions in terms of costs and benefits. The ROI is a criteria that is frequently used to evaluate the relative attractiveness of a resource allocation decision. The same approach has been applied historically to information systems decisions. However, the increasing complexity and interdependencies of these systems make it difficult to draw a boundary around the impacts of the proposed alternative and evaluate the associated costs and benefits. Additionally, many information systems changes add capabilities that did not exist previously, and the benefits of such changes are difficult to quantify. As a result, many systems management decisions are made based on factors other than ROI. Marketing considerations such as keeping up with competition or increasing technical

capabilities frequently have more impact on information systems decisions than an ROI that is based on a "soft" cost or benefit analysis.

Management Reporting

The amount of information upwardly reported in an engineering and construction organization must be carefully monitored. Modern information systems have the capability of moving large quantities of information quickly. However, this information must still be entered into the system, a process which is often labor-intensive. Organizations must discipline themselves and restrict information collection and reporting to only that which is truly needed. Every organization interviewed except one requires that only summary information be reported to senior corporate managers.

Corporate Support

The support of senior corporate executives is critical to the successful implementation of an information systems program. Without the support and involvement of senior executives, information systems frequently become disassociated from corporate objectives. Also, most major information systems projects require a significant corporate commitment of both money and time if they are to succeed – a commitment which is unlikely to occur if senior executives are not actively involved in the formulation of information system plans and decisions.

RECOMMENDATIONS

Managing information systems for large engineering construction organizations is a difficult task. The normal problems associated with information systems management are compounded by the technical nature of engineering and also by the technical abilities of engineers themselves. Engineers are used to logical progressions that, if done properly, lead to a supportable single best solution. The potpourri of technologies that are available, combined with conflicting objectives such as keeping up with technology and minimizing system costs, make identifying a best solution an elusive goal. The information systems strategies of well-managed engineering and construction organizations, however, provide valuable insights that can maximize the probability of an information systems modernization program being successful. To ensure that the maximum benefit is realized from these lessons

learned, we recommend the following concepts be incorporated into the Corps of Engineers Information System Master Plan:

- Develop separate finance and accounting and project management databases.
- Continue development of a new finance and accounting system.
- Procure an off-the-shelf project management system that will become the primary information system for Corps project management. Districts should be permitted to use other project management software; however, USACE should require that all reporting be done through the selected system and provide technical support for this system only. The selected system should possess the following general characteristics:
  - Be capable of being customized
  - Be capable of importing information from the new finance and accounting system
  - Be based on a 4th generation language
  - Be capable of supporting an internal or attached relational database
  - Have report writer or similar capabilities
  - Run on multiple platforms to include microcomputers
  - Be capable of having a microcomputer advance version available within 120 days of contract award.
- Continue development of a Corps-wide data dictionary which identifies data elements that can serve as keys to link these databases, thereby preserving the option of incorporating them into a single relational structure in the future. This effort should also scrutinize all proposed data requirements with the objective of limiting data collection to only information that is critical for effective management.
- Concentrate planning efforts on the next 5 years. Prioritize information systems modernization projects and select projects for implementation based upon both priority and funding considerations. A draft of a 5-year plan that emphasizes implementation issues should be presented to the ISMP Executive Steering Committee within 6 months.
- Ensure the responsiveness of information systems projects to organization needs by establishing firm milestone schedules that require the delivery of products 6 to 18 months after project initiation.

- Maintain corporate support of information systems modernization efforts by continuing the ISMP Executive Steering Committee and naming a senior executive to head up ISMP efforts.

We believe that the recommendations contained in this report, along with those of the Private Sector Council and internal USACE evaluations, provide the basis for a reevaluation and redirection of the Information Systems Modernization Program.

APPENDIX A

LIST OF INDIVIDUALS INTERVIEWED

APPENDIX A

LIST OF INDIVIDUALS INTERVIEWED

The Port Authority of NY & NJ

Mr. Jon S. Weston
Manager
Capital Programs

Mr. Dennis J. Switaj
Capital Program Support
Management and Budget Department

Fluor Daniel, Greenville, S.C.

Mr. R. J. Parker
Vice President, Construction

Mr. W. Keys Lewis III
Senior Director
Information Systems

Mr. Alan C. Waite
Principal Project Controls Engineer

Mr. Richard C. Forrester III
Business Development Manager
Defense Programs

Mr. Harrell H. Waldrop
Director
Maintenance Consulting Services

Mr. Ronald J. De Pietro
Director
Estimating

Edwards Kelcey, Livingston, N.J.

Mr. Robert Marshall
Director
Information Systems

E.I. DuPont De Nemours Company, Inc., Newark, Del.

Mr. J. R. Hanby
Engineering Department

Mr. James F. Collins
Manager
Computer Systems and Support

Lummus Crest Inc., Houston, Texas

Mr. Robert K. McClammy
Vice President
Finance

Mr. Nick J. Lamonte
Vice President
Finance – USA

Mr. Mark Marlin
Manager
Project Controls and Estimating

Mr. Angus A. Morrison
Manager
Systems Support

Morrison – Knudsen Co., Boise, Idaho

Mr. Jim Lilly
Senior Deputy
Consultant

Mr. Jim Colby
Assistant Corporation Comptroller

Dr. James M. Neil
Director
Management Systems

Mr. Dennis C. Hammond
Manager
Project Control

Mr. W. Kingery
Manager
Project Support

Mr. Pete Hedberg
Manager
Project Support

APPENDIX B

RESPONSES TO SOFTWARE VENDOR QUESTIONS

APPENDIX B

SOFTWARE VENDOR QUESTIONS
PRIMAVERA SYSTEMS, INC.

1. Is your software considered a complete "off the shelf" package or is customization or programming typically involved?

Primavera products are completely "off the shelf." No additional programming functions are required.

- **What hardware is it best run on?**

Primavera PC products operate best on faster processing equipment, such as 286 and 386 machines. The VAX version operates best with VT-340 terminals.

- **What can't it run on?**

The PC version requires 512K RAM (640 recommended) and a hard drive. The VAX version requires two megabytes of main memory and 15,000 blocks of storage memory.

- **Compatible operating systems**

PC Version: MS-DOS 2.1 +

Vax Version: VAX VMS 4.7 +

- **What type of peripherals does it support? Not support?**

Primavera products support most laser, dot matrix and pen plotters.

2. How much customization can the software support?

Many clients have developed custom interfaces to communicate with their internal systems. This is accomplished through the import and export features. Primavera PC products import/export ASCII, dBASE and Lotus style file formats. Primavera Vax products import and export ASCII, Oracle, 20/20, Lotus and dBASE file formats.

- **Source code open?**

Source code is not available.

- **What type of customization has been done? Any examples?**

Anvil Corporation has developed a product entitled BATMAN/FH which assists in their efforts in controlling plant maintenance activities.

INTRAC Management Systems has developed a product to simplify the process of entering timesheet data and preparing summary reports.

Kelar Corporation has developed a product entitled PROJECAD to interface Primavision files with AutoCad.

Kelar Corporation has developed a product entitled The Portable Field Computer (PFC). The PFC is a hand-held device for reviewing and statusing schedule data while in the field. The PFC saves all your Primavera Project Planner (P3) schedule data in a format that P3 can read immediately to update your files.

Engineering Technologies has developed a product entitled Drawing Control System. The Drawing Control System is an on-line program for creating and maintaining multi-project drawing databases which interfaces directly to Pc.

G2 Inc. has developed an interface from their estimating package to P3.

Timberline Software is developing an interface from Precision Estimating to P3.

Fluor/Daniel has developed a communications link to their cost accounting system.

IT Corporation has developed a communications link to their cost accounting system.

Combustion Engineering has developed a link to their CEMMS Maintenance program.

U.S. Air Force at Arnold AFB (AEDC) is developing an interface between their financial management and work order systems to P3.

Lehrer McGovern International has developed an MIS system, for the Canary Wharf Project, which P3 is an integral component.

Bechtel, Inc. has developed a link to P3 with Bechtel Software products.

Ralph M. Parsons has developed additional internal custom reporting through the use of R&R with P3.

Microsoft and Primavera teamed up to create an interface link between Microsoft Project and P3.

InstaPlan Corp. is in the process of completing development of a link to P3.

Gilbane Building Co. has developed an internal information system of which P3 is a part.

General Electric has developed an internal information system, which P3 is a part of.

Blount International has developed a construction MIS system which integrates with P3. Recently they developed a module to track submittals. They wanted their system to have the "look and feel" of P3 screens (approved by Primavera Systems).

Many clients have developed Lotus and dBASE templates internally to enter data. This allows them to have clerical personnel assist in project control.

- **Who did the coding?**

The staffs of the various companies. Efforts depended on the complexity of the interface built.

- **How might this add to cost?**

This is an inexpensive method to customize an "off the shelf" technology.

3. What are the implementation requirements?

Teach yourself using the tutorial provided. The project management handbook is especially good as a reference, even for experienced project managers.

- **Training**

Primavera offers training throughout the United States. Our main facilities are located in the Philadelphia area, at our Headquarters in Bala Cynwyd, Pa. We also have training centers located in the following cities: Atlanta, Orlando, Chicago, Dallas, Houston, Los Angeles and San Francisco.

- **Who does this?**

Primavera Systems has a staff of trainers who teach Primavera products throughout the country. On-site training can be arranged.

4. What are some special features/functions your package has that others don't?

The main strength of Primavera is in the ability to provide project managers with the necessary tools to: Communicate, Coordinate and Control their projects and to use what-if analysis. Primavera products have ease of use and a great deal of power.

5. Are there security and internal control features?

Security and password protection is established by user.

6. How compatible is it with other software packages?

Primavera is fully compatible through the exchange of ACSII, dBASE and Lotus type file formats.

- **Import/export – how?**

Exporting of information is done via the export option from reporting section. Importing of Lotus and dBASE files is accomplished through the use of range names and database structures in the Import option in the reporting section. Importing of ASCII information is best accomplished through the batch system. The batch system is fully documented to assist in file transfer.

- **Relational databases?**

Yes, through ORACLE and dBASE (to the extent that dBASE is relational).

7. What is the state of use?

Primavera Project Planner is the leading supplier of project management software to the A-E-C market (ENR).

- **Who uses it? – names**

Primavera Project Planner (P3) is used in 48 out the top 50 contractors, as listed by ENR. Presently P3 is in use at many Corps District offices and is used by many contractors on Corps projects requiring CPM scheduling control.

- **How? What functions?**

P3 is used for the control of: project management, project planning, project control, and project scheduling.

- **Integration examples?**

See examples cited in question two.

- **Who are the hands-on users?**

Primavera Project Planner is used by project engineers and project planners. Users of P3 range from novice schedulers directly out of college being taught how to organize a job, to senior level schedulers.

8. How might it be used across an organization?

Management must establish a structure for planning control and reporting. The work breakdown structure is to integrate information for each level of management.

As discussed at the presentation on Feb. 14, 1988, reporting from the project level to district level and finally upward to the senior management level in Washington is a straight forward process of summarizing detailed information to desired levels within each district.

- **Examples**

Parade is our product for performance measurement. It is used by government agencies and contractors to collect, analyze, and report on projects within a WBS format.

9. Can the software support distributed processing and or distributive storage?

Primavera supports distributed project controls. The project must be stored on a common server for reporting purposes.

- **Example**

If you have 3 different groups working on a common project, it is possible to easily merge their efforts into a common project for overall reporting.

10. What kinds/how much software maintenance have you done for customers?

Primavera provides updates and enhancements and telephone technical support. This is arranged on an annual contract basis.

11. Do you plan any changes – added features, etc., in the near future?

We are constantly improving our products.

12. What are any existing limitations, drawbacks? What would you look at improving or changing?

No known limitations. There is always another way to simplify life for the user.

13. What kinds of reports does the software produce?

Schedule reports, Bar chart reports, Resource reports, Cash flow reports, Productivity reports and earned value reports.

14. How many projects can your PM software handle?

Unlimited.

15. What about in a network environment?

Primavera Project Planner will work in a network environment. Our file format is Btrieve based, a Novell Co.

- **Users –**

Number of users subject to licensing provisions.

- **Databases –**

P3 will communicate the dBASE files on the PC. P3 communicates with ORACLE and dBASE on the VAX.

- **Platforms – micro, mini, main**

Primavera Systems, Inc., supports MS-DOS/PC-DOS software for PCs and PS/2s. OS/2 support is planned to be available in 1989.

We support VAX VMS at the present time.

SOFTWARE VENDOR QUESTIONS
AGS MANAGEMENT SYSTEMS, INC.

1. Is your software considered a complete "off the shelf" package or is customization or programming typically involved?

WINGS is considered a complete "off the shelf" package.

- **What hardware is it best run on?**

  IBM mainframe and PCs: DEC VAX

- **What can't it run on?**

  Non-IBM and non-DEC VAX computers.

- **Compatible operating systems?**

  IBM mainframe: MVS/TSO; VM/CMS
  IBM PCs: MS/DOS
  DEC VAX: VMS/FMS

- **What type of peripherals does it support? Not support?**

  WINGS supports:
  High speed, dot matrix printers
  Laser printers
  Color graphics printers
  Drum plotters
  PCs: IBM, Epson, HP, AT&T

2. How much customization can the software support?

WINGS software can be customized by either the client or AGS/MS.

- **Source Code open?**

  Source code is available.

- **What type of customization has been done?**

  Types of customization are screen formats, import/export of data, reports.

- **Any examples? Who did the coding?**

  Example of a customized screen format for time charges is attached.
  Coding was done by AGS Management Systems.

- **How might this add to cost?**

  Customization costs are based on time and materials.

3. **What are the implementation requirements?**

   AGS staff provides implementation support.

- **Load-up**

  AGS technical support will load the software at the client's site.

- **Data loads**

  AGS will load test data and verify that the software conforms to the client's naming conventions.

- **Testing**

  AGS will test the software to verify that the system operates in the client's environment. These three steps typically take one day.

- **Training**

  Training encompasses: Implementation Planning; Integration with Standards; System Administrator Training; Project Leader Training; Customized Training.

- **Who does this?**

  AGS Management Systems conducts all phases of the training.

- **Manhour estimates?**

Installation	1 Day
Implementation Planning	2 Days
Integration Workshop	2 Days
System Administrator Session	4 Days for 2 people

Additional training can be contracted on a per diem basis.

4. What are some special features/functions your package has that others don't?

WINGS will schedule multiple projects respecting limited resource availability, calculating the critical path according to resource availability. WINGS is real-time for all functions with on-line analysis screens for evaluating project schedules and resource utilization.

5. Are there security and internal control features?

WINGS has internal security to control read/write access to the data. There are ten levels of security with read and write access independently defined. The security controls the amount of data that may be accessed and the level of information.

6. How compatible is it with other software packages?

WINGS has its own database that can interface to other software packages.

- **Import/export – how**

  WINGS can import data through the WINGS Universal Interface which formats data into WINGS readable screens. The WINGS Report Writer has the ability to create an export file that captures WINGS data in a transaction file format.

- **Relational databases**

  Currently in development is a plan to write WINGS in DB2 with SQL. The anticipated effort is 12 to 18 months.

- **Integration capabilities**

Automatic interfaces can be built to integrate WINGS with other software packages, e.g., cost accounting, billing, general ledger, in order to avoid duplicate data entry.

- **Any examples**

  Examples of interfaces can be provided by the WINGS client base.

7. **What is the state of use?**

   WINGS has been available for the past three years.

- **Who uses it? – names**

  Attached is a list of current WINGS clients.

- **How? – What functions**

  Primary applications for WINGS are data processing and engineering.

- **Integration examples**

  Attached is an example of WINGS integration.

- **Who are the hands-on users?**

  Hands-on users vary from decentralized use of all users to centralized control. Typically, WINGS is implemented with centralized control in the Project Office for data entry and manipulation, and decentralized use of analysis, simulation and time tracking.

CLIENT LIST

Company	Location
Appleton Paper	Appleton, WI
AGS/IS	Clark, NJ
AT&T	Bala Cynwyd, PA
Baxter Healthcare	Chicago, IL
Burlington Northern R.R.	St. Paul, MN
Carrier Corporation	Syracuse, NY
Citizens & Southern National Bank	Atlanta, GA
Clorix	Oakland, CA
Columbia University	New York, NY
Combustion Engineering	Windsor, CT
Dow Jones & Company	South Brunswick, NJ
Engelhard Corporation	Iselin, NJH
Giant Foods	Landover, MD
GTE Directories	Dallas, TX
LDS Church	Salt Lake City, UT
Manufacturers National Bank	Detroit, MI
Massachusetts Blue Cross/Blue Shield	Boston, MA
Matsushita Electric	Secausus, NJ
Molex	Lisle, IL
Moore Financial	Boise, ID
Navistor	Chicago, IL
New York Life	New York, NY
Northeast Utilities	Wethersfield, CT
Northwest Airlines	Minneapolis, MN
NYNEX Information Resources	Lynn, MA
Otis Elevator	Farmington, CT
Pennsylvania Blue Shield	Camp Hill, PA
Pittsburgh National Bank	Pittsburgh, PA
Polk County	Des Moines, IA
Shearson Lehman Hutton	New York, NY
Sikorsky Aircraft	Stratford, CT
South Carolina National Bank	Columbia, SC
State of Hawaii	Honolulu, HI
Union Pacific R.R.	St. Louis, MO
USF&G	Baltimore, MD
U.S. Sprint	Kansas City, MO
Walgreen	Deerfield, IL
Whirlpool	Benton Harbor, MI

8. **How might it be used across an organization?**

WINGS can be used by any department throughout the organization. WINGS security will prevent unauthorized access by department code.

- **Data sharing/networking**

  Data may be shared on a common database in WINGS. Individual departments/offices would update and simulate their own projects. Roll-up reports would display data for all projects throughout the organization.

- **Regional offices**

  Regional offices may download their data from the central CPU to a PC. Updates, changes and simulations may be done on the PC and then updated back to the mainframe for organization-wide reporting and analysis.

- **Examples**

  Attached is an implementation plan for WINGS.

9. **Can the software support distributive processing and/or distributive storage? Examples.**

WINGS can support distributive processing through the use of the mainframe/PC connection. The mainframe is used for the centralized file with the PC for distributive processing. WINGS will support distributive storage through the use of multiple databases.

10. **What kinds/how much software maintenance have you done for customers?**

AGS offers a 24-hour hotline for questions and problems on the software. Minor maintenance and fixed can be done through phone conversations or as lines of code. This is part of the client Support Plan offered to WINGS clients.

11. **Do you plan any changes – added features, etc., in the near future? Why?**

New releases of WINGS are offered each year with changes that have been requested by the client base and prospective users. The next major release of WINGS is scheduled for March, 1989, with the mainframe/PC download/upload connection.

12. What are any existing limitations, drawbacks? What would you look at improving or changing?

The most frequently requested improvements to WINGS is to expand the analysis/reporting function. Other enhancements planned for the next release are to make the data entry screens easier to use.

13. What kinds of reports does the software produce?

WINGS has standard reports for on-line analysis and hard copy, screen graphics that can be printed, a Report Writer for customized reports and optional plotter graphics.

- **Can they be customized?**

  Standard reports can be customized through user-selected data exception/selection criteria. Time scales can be adjusted to fit the user's needs.

- **Can special-user reports be easily generated?**

  Special, customized reports can be generated through the on-line Report Writer. The user selects the report parameters and creates the report for terminal or hard copy review. Report parameters can be stored and reused. WINGS also has a similar function for creating user-defined gantt charts that can be printed on a character printer or in color off a PC.

14. How many projects can your PM software handle?

There is no limit to the number or size of the projects that can be scheduled by WINGS.

15. What about in a network environment?

WINGS will operate on LANs, WANs, and clusters with the configuration specified in Item #1.

- **Users**

  There is no limit to the number of WINGS users on the network.

- **Databases**

  The WINGS database(s) would be defined as described above in Items #8 and #9.

- **Platforms – micro mini-main**

  The network can be:

  - PCs with a file server,
  - PCs attached to a mini or mainframe host,
  - VAX mini computer cluster.

SOFTWARE VENDOR QUESTIONS/ANSWERS
METIER MANAGEMENT SYSTEMS, INC.

1. Is your software considered a complete "off the shelf" package or is customization or programming typically involved?

ARTEMIS is a 4th Generation language which has additional special commands that are specifically for project management. The user uses this language for all processes within ARTEMIS, therefore, customization is not applicable. In addition to the language, Metier has quite a few "off the shelf" applications that have been written in the ARTEMIS language. These applications typically provide between a 70 and 100% solution for our clients. The applications can then be easily customized to fit the clients needs. This customization can be done either by Metier personnel or by the client.

- **What hardware is it best run on?**

  There are several factors that should be taken into consideration whilst deciding which hardware ARTEMIS should run on such as number of users, amount of data/transactions, etc., existing hardware and so on. ARTEMIS will run equally well on the following hardware:

ARTEMIS 2000:	IBM PC-AT, 386 and compatibles
ARTEMIS 6000:	Hewlett Packard 1000 mini-computer (turnkey)
ARTEMIS 7000:	DEC VAX mini-computer
ARTEMIS 7000U:	Unysys 5000/80 mini-computer
ARTEMIS 9000:	IBM Mainframe and plug compatibles (i.e., AMDAHL, SIEMENS, COMPAREX, BASF, HITACHI, FUJITSU and NAF)

- **What can't it run on?**

  Currently any hardware that does not support the necessary operating systems. (See next question.)

- **Compatible operating systems?**

DOS	on IBM PCs and compatibles
HP RTE+	on Hewlett Packard mini-computers
VMS	on DEC VAXs
UNIX	on Unisys 5000/80
MVS/TSO or VM/CMS	on IBM mainframes and plug compatibles

- **What type of peripherals does it support? Not support?**

ARTEMIS 2000

Monitors

Monochrome	CGA	EGA	VGA

Printers

IBM Graphics Printer and 100% compatibles

Printer/Plotters

IBM Proprinter	HP 2934
HP 256x	HP LaserJet
HP Rugged Writer	Epson RX-80
Plotters	
Calcomp 104x	HP 7475
HP 7550/7570	HP 758x
HP 759x	Roland HP Compatibles
Bruning ZETA	

ARTEMIS 7000

Terminals

DEC VT-1xx	Tektronix 410x
DEC VT-2xx	Tektronix 4207
DEC VT-3xx	

Printers

Any printer addressable on a VMS PRINT queue.

Plotters

Calcomp 104x
Calcomp Colorview 5912
Benson pen plotters using ISDP

HP pen plotters
HP LaserJet
HP 2563
HP 2934
Zeta 8 Series
Zetadraf 900
Roland DXY-825/890

ARTEMIS 9000

Screen-Formatted Terminals

IBM 3278	IBM 3279	IBM 3178
IBM 3192	IBM 3290	IBM 8775
IBM 3270 PC	IBM 3179/G	IBM 3192G

Line by line Terminals

HP 2621	HP 2647	HP 2645
HP 2649G	IBM PC	

teletype comparable terminals

Printers

Any locally or remotely attached printer that is capable of receiving print directed through MVS or VM Operating System utilities.

Graphic Post-Processors

The following ARTEMIS Post-Processors allow the connection of a wide range of graphic devices:
GDDM Post-Processor
CA-DISSPLA Post-Processor
Calcomp Post-Processor
Tektronix Post-Processor

2. How much customization can the software support?

Because all the ARTEMIS applications are written in the ARTEMIS language, the applications can be customized as much as necessary. There is no limit to the number of changes that can be made.

- **Source Code open?**

  All the source code for the applications on mainframe and HP mini ARTEMIS is open code. If the client has at least one ARTEMIS Full Language user, he can use the language to make changes to the code himself.

- **What type of customization has been done?**

  Clients who buy the ARTEMIS applications pretty much have a complete "off the shelf" solution in their hands. Normally the type of customization that is done is simple and quick such as changing terminology within the menus, adding additional reports and graphics, changing the titles and headings, changing a couple of screen layouts and so on.

  A few of our clients have felt that the "off the shelf" applications really don't fit their mode of operation, therefore, rather than trying to completely customize the Metier built applications, they build their own from scratch.

- **Any examples? Who did the coding?**

  We have numerous clients who have made minor changes to Metier applications as well as many clients who have built their own. In the case of the large applications, they have normally been written by Metier Professional Services. Smaller applications are normally written by the users. For example Carolina Power and Light have over 50 applications that they have written themselves. Where as the New York Port Authority had Metier do everything from writing the detailed specification, coding the application, producing documentation and training manuals, to giving the training.

- **How might this add to cost?**

  Obviously this would be dependent upon who was to do the coding. Complete ARTEMIS language training is included in the cost of any of the ARTEMIS language modules. Therefore, users could be trained and within a few weeks could be ready to write their own applications.

  The cost would also depend upon whether an existing "off the shelf" application was being used as a base and then being customized or whether

a complete new application was being built. Of course the size and complexity of the application would also effect the cost.

If Metier were to do the coding, a specification and an estimate of the cost would be done before any coding began.

3. **What are the implementation requirements?**

- **Load-up**

  Loading the ARTEMIS software on a mainframe takes approximately half a day, however, we like to allow two days in case of complications, and also for testing purposes (see below). The ARTEMIS software can be loaded onto the mainframe without having to stop any other users on the system from working.

  Installation of ARTEMIS on the VAX and Unisys machines, normally takes half a day and usually doesn't require the users already on the system to stop working. Another half day is usually reserved for testing purposes.

  Installation of an ARTEMIS turnkey mini (HP), takes approximately half a day, with the other half of the day reserved for testing purposes.

  Installation of the ARTEMIS software on a PC, takes one hour.

- **Data loads**

  The time required to load data on the system is dependent upon the amount and the type of data.

- **Testing**

  After installation of the software, the Metier Consultant will run a Confirmation Test, that runs through all the language options and ensures all have been installed correctly and are working. Any applications are also tested out. Output will be sent to the screen, plotters and printers to ensure they have also been configured correctly.

- **Training**

The Metier Consultant will train an appointed "System Manager" in all system manager type functions such as allocating ID's, passwording, back-ups and so on. This training is given the day of installation.

Training for two people in the use of all applications and language modules purchased, (other than ARTEMIS 2000, which can be purchased separately), is included in the cost of an ARTEMIS system. This training can be given on site, or at any one of the four Metier Training Centers across the U.S.A. The Training Centers also run all the ARTEMIS courses year round. Anyone can book on to these courses.

If a custom application has been built for a client by Metier, we will also produce training documentation and run the training courses.

- **Who does this?**

  All Metier trainers are professional people proficient in the use of the ARTEMIS language and applications. Occasionally, Metier uses independent Training Consultants who are also well versed in the ARTEMIS language and applications.

- **Manhour estimates?**

  Please refer to the "Customer Training Brochure" attached to this document.

4. What are some special features/functions your package has that others don't?

Most other project management applications are pre-built and cannot be changed by the customer, "what you see is what you get" and you have to live with that. All ARTEMIS applications are written in the ARTEMIS language, whether they be for cost, project management, resource management, manufacturing or whatever. The customer has the opportunity to purchase that language as well as the actual applications, therefore he has all the tools necessary for customizing the applications to meet his own requirements. By having the language, not only can he customize the Metier applications, but he can easily build his own.

ARTEMIS uses relational technology and a fourth generation command language. These features give the flexibility needed to rapidly design new applications and make additions or changes to existing ones. In addition, the applications themselves can be made extremely versatile, by designing full use of these features into the application.

ARTEMIS is a truly integrated package. With some other Project Management software, you have to buy separate, independent packages for project management, report writing, graphics and database, learn each of their separate languages and/or menus, and work out how to interface the data between them. ARTEMIS is a single software package with one language, used for all project management functions as well as graphics, custom report writing and database capabilities.

5. Are there security and internal control features?

The following features are found in ARTEMIS 9000:

The user can allocate various levels of password protection. He can assign a password to a user ID and to an ARTEMIS project (all the activity networks, user defined datasets, descriptions tables, resources, calendars etc., are contained within an ARTEMIS project). The user can also assign passwords to data and command files and even to individual datasets.

One of the ARTEMIS ID's is predefined as a System Managers ID. The System Manager allocates all the ID's for the other users as well as performing "house-keeping" type functions.

Data may be kept in ARTEMIS "library datasets" that have permissions set up. Some users may have read access, others read and write, where as others can read, write to and delete the data. The owner of the library dataset sets up the permission structure.

Passwords can also be assigned to the VM or MVS mainframe logon ID.

An ARTEMIS "Run-Time" user is restricted to only having access to the Metier application menu screens or any user-defined applications. These users will not have access to the ARTEMIS language.

With the ARTEMIS "Exit for Extended Security" feature, a customer installation can enhance the security of an ARTEMIS system and the data within that system. The system manager can write his own security module which is invoked by ARTEMIS on initialization, termination, and whenever any ARTEMIS command attempts to access any ARTEMIS data. This feature provides maximum flexibility in the way security is implemented for ARTEMIS. The following are examples of features which can be incorporated into a security module:

The system will write the details of any access to any ARTEMIS ID, project, dataset or file to a log;

The customer can implement expiration dates for ARTEMIS passwords;

The customer can place additional restrictions on the content of the passwords;

The customer can incorporate a feature which revokes a user's access when he repeatedly enters an incorrect password.

Because with the ARTEMIS Exit for Extended Security the system can write information to a log, the customer can use this feature to compile accounting information.

The ARTEMIS "Failsafe" mechanism underlies all ARTEMIS operations on user data. This mechanism projects the database from even the most catastrophic failure, e.g., session cancellation or CPU failure. Failsafe insures that, following such a fault during updating or any other ARTEMIS process, the system returns the user's data to the same state in which it existed before the process began. In addition, with ARTEMIS Failsafe, the user can "undo" the last command and, thus, protect against mistakes made by the terminal operator. FAILSAFE wins over conventional rollback/rollforward transaction processing in that no additional I/O activity is needed and no logging space is required to record transactions for backout processing. With ARTEMIS, the user can also override default check-points and conditionally control the updates which are applied to the database. All of these security features are built into the software and are proprietary.

The following features are found in ARTEMIS 7000:

ARTEMIS 7000 runs on Digital Equipment Corporation VAX and MicroVAX computers running the VMS and MicroVMS operating systems. VMS and MicroVMS have username/password logon security protection.

ARTEMIS 7000 has username/password security. The ARTEMIS System Manager assigns usernames and passwords.

Each ARTEMIS "object" (examples of objects are partitions, datasets, documents, calendars, etc.) contains an access permissions list which determines which usernames can perform which types of processing (e.g., none, read only, read and write, delete). Permissions are assigned by the creator of the object.

An ARTEMIS 7000 Run-Time user is restricted to running Metier or user-supplied applications, and cannot access the ARTEMIS language to add to or modify an existing application.

ARTEMIS 7000 incorporates a "Failsafe" mechanism similar to ARTEMIS 9000, protecting data from catastrophic system failure. The "Failsafe" mechanism is completely automatic; there are no user commands required to control it.

6. How compatible is it with other software packages?

Through the use of the ARTEMIS IMPORT/EXPORT features, data may be passed from other systems via flat files into ARTEMIS for processing and reporting. ARTEMIS data can also be exported to DOS, VMS, and OS files for importing into other packages.

ARTEMIS Project, the ARTEMIS application that runs on a PC, DEC VAX and Unisys 5000/80 has a pre-built import/export facility to Symantec's "Timeline" product. In ARTEMIS Project there is an option to pass data, (that will be converted into a format readable by Timeline), to the Timeline application. In Timeline there is an option to pass data directly to ARTEMIS Project which again will be converted into a readable format. There are also interfaces to ASCII, DIF, LOTUS and SYMPHONY.

ARTEMIS on the mainframe, which is itself based on relational technology, has been designed to work in and enhance the DB2 environment, supporting both SQL program statements and direct access to DB2 via the ARTEMIS 4GL.

The facilities, which are fully integrated into the ARTEMIS base language and data management system, drive the "Structured Query Language" as used by DB2. By implementing the SQL option, users of ARTEMIS will be able to use the DB2 database as if it were part of the ARTEMIS database. Data can be transferred between SQL tables, views and field definitions can be obtained on-line, and reports together with project management graphics can be created directly from the DB2 database. In theory most other databases which support an SQL interface can be accessed by ARTEMIS.

- **Import/export – how**

  Export - the user selects which records and which actual field values form those records are to be exported. The user can choose the order and the actual format the records are copied in. The data is exported to a flat file out in the operating system (either DOS, VMS, UNIX, VM/CMS or MVS/TSO). From there the flat file is imported into the destination package.

  Import - data is read from flat files into ARTEMIS by breaking the data down into columns and placing the values from each column into field on records, within ARTEMIS datasets.

- **Relational databases**

- **Integration capabilities**

- **Any examples**

7. **What is the state of use?**

ARTEMIS is an international company with offices in 26 countries around the world. There are close to 1,000 ARTEMIS sites world-wide not including our P.C. only sites.

- **Who uses it? – names**

ARTEMIS is used in numerous industries such as Aerospace Defense, Construction, Oil and Gas, Electricity, Water, and many more. As mentioned above, there are close to 1,000 ARTEMIS sites throughout the world, the following are but a tiny subset:

Morrison - Knudsen	O'Brien - Kreitzberg
Foster Wheeler Energy	Lummas Crest
H.K. Ferguson	O'Hare Associates
Martin Marietta	Lockheed
Boeing Strategic Petroleum	Adolph Coors Company
MW Kellogg	Parsons Brinkerhoff
CRS Sirrine	Marino Constructio Co.
New York Port Authority	Brown & Root
City of Denver	Continental Hellar Corp.

- **How? – What functions**

Our clients have developed over 3000 types of applications using the versatile ARTEMIS language. Many of these re quitre specific to their individual needs. Some of the more common functions include:

Accounting	Bid Preparation
Billing	Configuration Management
Contract Management	Cost Control
Cost Management	Document/Drawing Control
Earned-Value Reporting	Estimating
Inventory Control	Jobcards/Workorders
Maintenance	Materials Management
Personnel	Resource Management
Risk Analysis	Software Development
Timesheets	

- **Integration examples**

  Planning 9000 is a mainframe-based planning and scheduling application which shares data with Cost 9000, our cost management application. Each of these applications stands alone; together, they work as a cost and schedule control system.

- **Who are the hands-on users?**

  ARTEMIS is designed so that the project management staff can operate the machine. Programmers are not required, unless they are developing new applications or expanding existing ones.

8. **How might it be used across an organization?**

   - **Data sharing/networking**

     Planning 9000, our mainframe application for planning and scheduling, is an example of how ARTEMIS might be used across an organization.

     Planning 9000 is designed to support multiple projects. A Control User establishes corporate standard data, such as rate and escalation tables, company holiday calendars, etc., and controls the permissions system, giving responsible user(s) access to their project(s). The Control User also maintains the overall master project, called the Live Plan. When an individual project manager makes changes to a project, the Control User may investigate these changes before allowing them to become part of the Live Plan.

     Individual Project Managers control their project(s). They have full control over the input, updating, processing and reporting. They can store away generic "model networks," so that repetitive work can be rapidly planned based on previous experience.

   - **Regional offices**

     A small regional office might have a personal computer running ARTEMIS PROJECT, our PC-and-VAX based project management application. Nightly, the updates might be mailed to headquarters on a floppy disk, or

electronically transferred using ARTEMIS LINK, our terminal emulation software with file transfer capability.

A large regional office might have a DEC MicroVAX or VAX system running ARTEMIS PROJECT and/or the ARTEMIS 7000 language. The updates might be mailed to the headquarters mainframe on a 9-track tape, or electronically transferred using a "DEC Bridge" on the mainframe, connected to DECnet with an SNA link on the VAX.

9. Can the software support distributive processing and/or distributive storage? Examples.

ARTEMIS 2000, our Personal Computer software, will operate across a Novell or 3Com LAN. Multiple ARTEMIS users may use a single copy of ARTEMIS program code residing on the file server.

ARTEMIS databases are contained as single logical entities, and cannot be divided across multiple processors. Data transfer between databases can be accomplished by means of ASCII (micro- or minicomputer) or EBCDIC (mainframe) files.

10. What kinds/how much software maintenance have you done for customers?

Customers who have current maintenance agreements normally receive two releases a year on all platforms. One being a full feature release, the other for maintenance.

11. Do you plan any changes – added features, etc., in the near future? Why?

Metier has a large R&D Department that is constantly improving and developing the ARTEMIS product, in fact 17% of Metier's annual revenue is put back into R&D. As mentioned earlier, Metier normally comes out with two releases a year. These releases comprise of new features that clients have requested via their Improvement Request Forms and that Metier have developed to keep up with the ever-changing project management requirements.

At the National A.U.A. (ARTEMIS Users Association), the users vote on the 10 features they would most like to have in ARTEMIS. This list is presented to Metier who try to incorporate all of the features in subsequent releases. If a new feature brought out in the language affects an ARTEMIS application, Metier will bring out a new release of the application incorporating this new feature (assuming it is relevant), for those clients who are under a support agreement for their applications. The client will also receive training on the new features and either inserts for their existing manuals or complete new sets of documentation.

12. What are any existing limitations, drawbacks? What would you look at improving or changing?

Metier is always looking to improve the ARTEMIS software, as mentioned above there is a large R&D department whose job it is to do nothing but improve the product. Two of the main projects that the R&D department is currently working on is running the ARTEMIS software on more platforms and increasing its ability to work with other databases, the DB2 interface and the Fujitsu Mainframe being the first examples of this..

13. What kinds of reports does the software produce?

Virtually the only limitation on the types of reports that are produced is the imagination of the user. In the "off the shelf" application such as Planning 9000 on the mainframe, there are over 70 predefined reports ranging from tabular reports to graphical output. Even with these reports the user has the option to select which records re output and the order they appear. Using the ARTEMIS language, the user has complete control over the output of any and all reports.
Please see next question - "Can they be customized?"

- **Can they be customized?**

  The ARTEMIS user can produce his own custom reports by using the powerful ARTEMIS report writer which uses the same English- like command/query language as all the other ARTEMIS functions. The user can select records from any dataset and output the data in any order. The system will calculate subtotals, totals, averages, maxima and minima and

output these calculations as the report is produced. The user can automatically assign output formats to tailor the format of the specific report. The user can specify titles, subtitles, headings and footnotes in great detail. Control breaks permit new pages at specified values, headings, subheadings, totals and subtotals to be output at points determined by the data.

ARTEMIS also provides graphical reports in the form of network drawings, barchart (Gantt) drawings, and management graphics (XY or cost curves, histograms, profile histograms, piecharts and structured drawings). The Network Diagrams can be drawn from either Arrow or Precedence CPM networks. The user has control over the output, level of criticality, and all pen colors such as on the critical path, the filed information to be output, the text in the legend area and up to 3 symbols on any one activity. The diagram can be drawn logically paying no attention to time, or against a linear or variable timescale, where the timescale can be automatic or user defined.

Barcharts (Gantt charts) may be produced easily. The user has complete control over claendar lines and annotation, field and bars output. Titles, headings, footnotes, subtitles, legend area, pen colors, symbol annotation etc.

The user may generate his own graphics in the form of XY-cures (cost curves), profiles, histogrms, piecharts and structured drawings (OBS, or WBS drawings). Again the user has complete control over pen colors shade-styles, axis annotation, titles, footnotes and headings, etc.

The use can generate these graphics to any ARTEMIS graphics device including graphics terminal displays, line printer/plotter, page plotters, continuous feed plotters and electrostatic plotters. With ARTEMIS the plotters produce presentation quality graphics.

- **Can special-user reports be easily generated?**

  Yes. Custom user reports can be produced at any time. Please see above (Can they be customized?)>

14. **How many projects can your PM software handle?**

ARTEMIS 2000 - PC
exceeds 5,000

ARTEMIS 6000 - HP 1000 minicomputer
exceeds 16,000

ARTEMIS 7000 - DEC VAX
exceeds 50,000

ARTEMIS 7000U - Unisys 5000/80
exceeds 50,000

ARTEMIS 9000 - Mainframe
up to 3,780,000

15. **What about in a network environment?**

- **Users –**

  ARTEMIS 2000, our Personal Computer product, will operate across a Novell or 3Com Local Area Network (LAN). Multiple users can simultaneously access a single copy of the ARTEMIS programs stored on the file server. Both local and network printers and plotters may be accessed by the ARTEMIS users.

  Each ARTEMIS user must have their own database; concurrent access to data is not supported. Data may be transferred between users via ASCII files.

- **Databases –**

  Each user's database may be a DOS file on either the local CPU's hard disk or on the file server. In addition, the user may establish a non-DOS partition on the local hard disk, and install an ARTEMIS database on it.

- **Platforms – micro, mini, main**

  ARTEMIS 2000 runs on Novell and 3Com Local Area Networks (LANs) on personal (micro-) computers.

ARTEMIS 7000 runs on the Digital Equipment Corporation's VAX line under the VMS operating system. VMS supports networking and clustering of computer resources; ARTEMIS 7000 has cross-cluster support